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Biotech food - and no controversy: trehalose to find more food functions as cost falls.

Scher, Marvin

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ABSTRACT: Trehalose, a natural disaccharide, can be used to dry and preserve many foods. It decomposes to create simple sugars, such as glucose and fructose. Many plants and animals synthesize trehalose naturally, especially under stress of heat, freezing or drying. It is used in drying mushrooms, bakers yeast and dried eggs. High cost has discouraged its use in most food developments.

TEXT:

Cost counts when you're a food processor, so it's always good news when the price of an ingredient goes down instead of up. And if work at Calgene is successful, a simple sugar with important properties is going to get a lot less expensive. The disaccharide trihalose - now selling at $100 to $200/lb - will be priced near $1.50/lb when produced from sugarbeet and sugarcane.

Similar to sucrose

Trehalose is a naturally occurring disaccharide similar to sucrose, which hydrolyzes to the simple sugars glucose and fructose. When trehalose hydrolyzes, it yields only two molecules of glucose.

Many plants and animals naturally synthesize trehalose, particularly when subjected to the stress of freezing, heating and drying. Common edible foods such as baker's yeast, shrimp and mushrooms can contain up to 20% trehalose dry weight.

More exotic life forms - insect pupae, spiders and cryptobiotic plants - also store large amounts of the sugar. Trehalose protects life-giving proteins, prevents loss of volatile components and provides a source of quick energy. For example, some dry "resurrection" plants can be heated to 100 C, and exposed to high vacuum and large doses of radiation without being destroyed. At room temperature, "resurrection" plants can survive for more than 50 years in a dry state and spring back to life after wetting.

More commonly, baker's yeast can be kept on the shelf in a dry state indefinitely, and yet leaven bread within minutes of being rehydrated.

Wide-ranging

food uses

Early on, the protein protective properties of trehalose suggested similar additive uses in foods, and these applications have been investigated for many years. For example, when 5% trehalose is blended with fresh eggs and dried at 45 C, the resulting odorless yellow-orange powder can be stored at room temperature and easily rehydrated to a product almost indistinguishable from fresh eggs.

Similarly, a wide variety of foods have been found to retain texture, [illegible], taste and cooking properties when dried with trehalose. Because trehalose is only about 45% as sweet as sucrose, the small effective amount [illegible] adversely change flavor. Frozen foods, sauces, concentrates and [illegible] application areas.

[illegible] trehalose in drying fresh foodstuffs

[illegible] investigations of trehalose in drying [illegible] of fruits involve [illegible] unexpected result. The "fresh" characteristics of fruits [illegible] the release of aromatic molecules. Fresh [illegible]

fruits pureed with trehalose and dried at 25 C to 50 C showed no detectable changes in properties during prolonged storage, and the dry powders had essentially no aroma. When reconstituted with water, the properties of the fresh purees were restored, including the aromas unique to fresh fruits. When dried without trehalose, the same fruit purees were more difficult to reconstitute and had characteristic cooked flavors.

Because the high price of trehalose has discouraged its use, food applications are relatively undeveloped. Quality improvements might be seen in areas as diverse as prepared meals, spices, coffee, tea, cereals, powdered milk, juice concentrates, soups, sauces and dried fruits.

Complex mechanisms

The ability of trehalose to entrap volatile components is attributed to non-hygroscopic glass formation on the surface of food substances. During the drying process, the sugar coating immobilizes and stabilizes large molecules, but allows water to diffuse and drying to occur. Comparative chromatograms showing volatiles in the head space above fruit powders provide dramatic evidence of the trehalose effect. As your nose would predict, chromatograms show a crowded spectra of peaks for normally dried puree, but for the trehalose-containing products, the chromatograms are almost empty.

Protein stabilization is thought to be the result of hydrogen bonding, with sugar molecules replacing surface bound water. Trehalose is one of the most stable sugars; it does not caramelize and cannot yield Maillard reactions with proteins. Flexibility of the trehalose disaccharide bond was thought to allow conformity to irregular surfaces of macromolecules.

New source of trehalose

In November, Calgene licensed the genes that convert glucose to trehalose from a Norwegian research team. Using biotechnology know-how and crop production facilities, Calgene plans to introduce copies of the trehalose genes into sugar-producing crops. In January, Calgene formed a joint venture with Quadrant Holdings Cambridge Ltd., a pioneer in research on food and pharmaceutical uses of trehalose. The new venture, Osmotica Foods, will have access to Quadrant's food patents and will be positioned to quickly capitalize on developing both product and markets.

Initially, the focus will be on developing products using trehalose produced by fermentation. As sufficient fermentation production is reached, costs should approach $20/lb for trehalose. Osmotica Foods intends to license food companies and to develop its own products.

Regulation not an obstacle

Trehalose occurs naturally in a large variety of foods, and the enzyme that splits it into two glucose molecules is present in human intestines and plasma. Unlike other disaccharides, notably lactose, trehalose intolerance is a rarity.

Early in 1991, trehalose was approve as a novel food in the United Kingdom, and it is currently used in pharmaceuticals in the United States. Although not now approved for food use, there should be no obstacles in obtaining FDA clearance. Osmotica will request Generally Recognized As Safe (GRAS) status for the sugar, and estimates this will be granted before the end of 1993.

Another Calgene product, the biotechnology derived FLAVR SAVR [R] tomato, contains minute amounts of marker gene protein, and this has been used as a lever by activist groups to generate controversy. The cane and beet plants from which trehalose will be purified, however, are not intended to be eaten, and the source of the sugar is irrelevant. It is unlikely that activists can find even remote grounds to obstruct this biotechnology development.

More information may be obtained from Osmotica Foods, Inc. 1920 Fifth St., Davis, CA 95616.

SPECIAL FEATURES: illustration; photograph; chart
INDUSTRY CODES/NAMES: FOOD Food, Beverages and Nutrition
DESCRIPTORS: Carbohydrates--Product development; Hydrolysis--Usage; Drying agents--Product development